Volume 37 February, 1951 *Number 2*

Lubrication

A Technical Publication Devoted to the Selection and Use of Lubricants

THIS ISSUE

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IN THE
SOAP INDUSTRY

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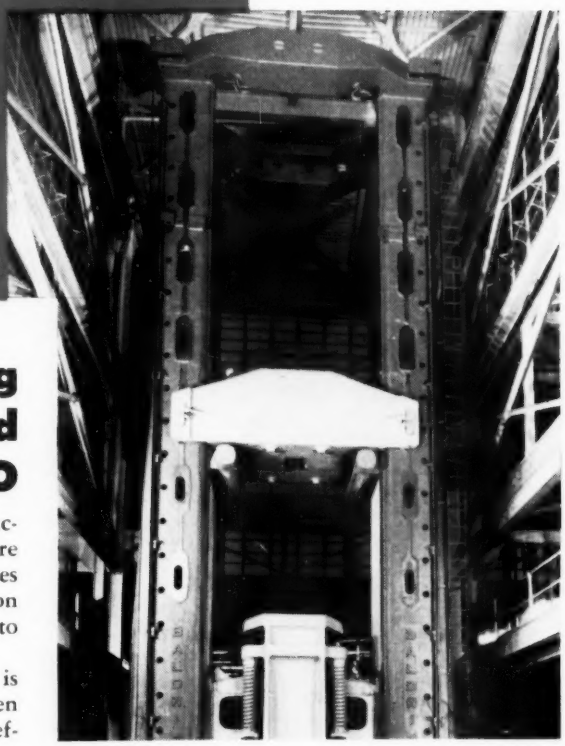

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LUBRICATION

A TECHNICAL PUBLICATION DEVOTED TO THE SELECTION AND USE OF LUBRICANTS

Published by

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Lubrication in the Soap Industry

WHETHER we can associate soap-making with religion is debatable — at least there is an old "saw" to the effect that "cleanliness is next to godliness." Both have become more and more accepted with the advancement of civilization. The general process of soap-making, however, remained virtually static until science discovered a process for making soda from salt around the beginning of the Nineteenth Century. This led to the idea of compounding fats with soda — a far more economical procedure than the primitive method of leaching wood ashes with hot water to obtain potash.

From these beginnings, has developed an industry — lately turned to the active development of detergents — which is one of the most vital in our system of modern life. To realize the importance of soap, all we have to do is recollect the drives to save fats during the recent war years, or to talk with peoples whose countries were lacking in soap. Literally a cake was sometimes more valued than precious metals.

It was this scarcity of fats which urged science to investigate the manufacture of detergents from petroleum by-products. It was the success attending this research which prompted the soap industry to undertake the manufacture of synthetic detergents in granule and liquid forms. Today, these materials have a definite place in the household as well as in industry. They go hand-in-hand with conventional soaps in promoting easier cleanliness, better health, greater resistance to infection, and the production of a wide range of materials used in industry.

SOAP IN INDUSTRY

The layman is most familiar with soap as a household material. It is interesting to mention some of the other uses which have led to improved production in industry. For example:

1 — A soapy solution is used as a catalyst carrier in combining certain of the ingredients required in making synthetic rubber.

2 — Soap is the lubricant in tire molds to prevent rubber tires from sticking to the mold walls during the vulcanizing process.

3 — Soap is the die lubricant in wire drawing to give high polish to the strands.

4 — Soap is used as a roll lubricant in rolling metal foils such as aluminum, tin and lead.

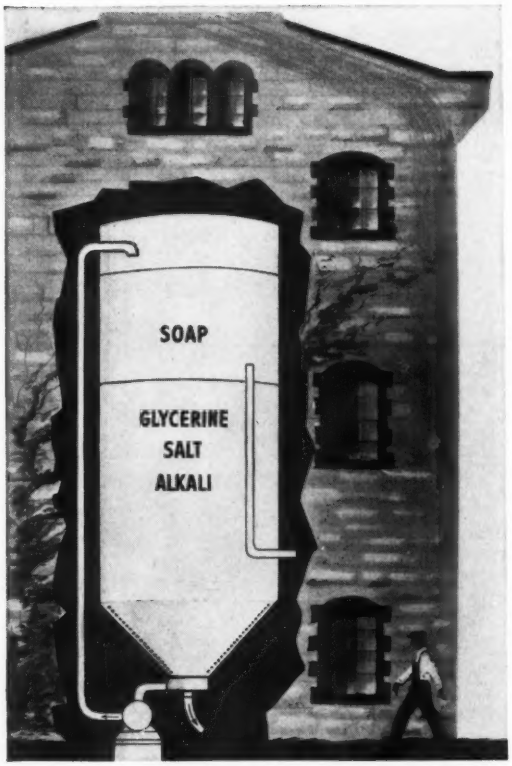
5 — A soap solution is used to soften leather.

6 — Soap is used as a polishing material on both hard woods and jewelers metals.

7 — Soap is an essential in making lubricating greases in compound with selected petroleum oils.

SOAP IN LUBRICATING GREASES

The fact that soaps are so widely used in the manufacture of lubricating greases justifies a discussion (for the benefit of the operator of soap-making machinery) as to just how these compounds fit in with the maintenance schedules for his machines.



Courtesy of The Proctor & Gamble Company

Figure 1 — Schematic view of a 3 story soap kettle.

Greases for conveyor, motor and fan bearings must be thoughtfully selected in the soap industry due to the need for preventing any chance of contamination or discoloration of the soap. Oil or grease drip can have about as serious effect upon production as actual bearing wear. That is why modern designs of anti-friction bearings especially provide for positive retention of lubricants. It is only necessary to use the lubricants intelligently, assuming that they have been selected in accordance with the operating conditions and methods of lubrication.

The pressure gun and compression grease cup are well suited for servicing grease-lubricated bearings when carefully manipulated. The grease capacity of many of these bearings on soap-forming or cutting machinery is quite low — oftentimes, less than an ounce is necessary; furthermore, any such bearing should never be filled full of grease. About half-full is best.

Stability is Most Important

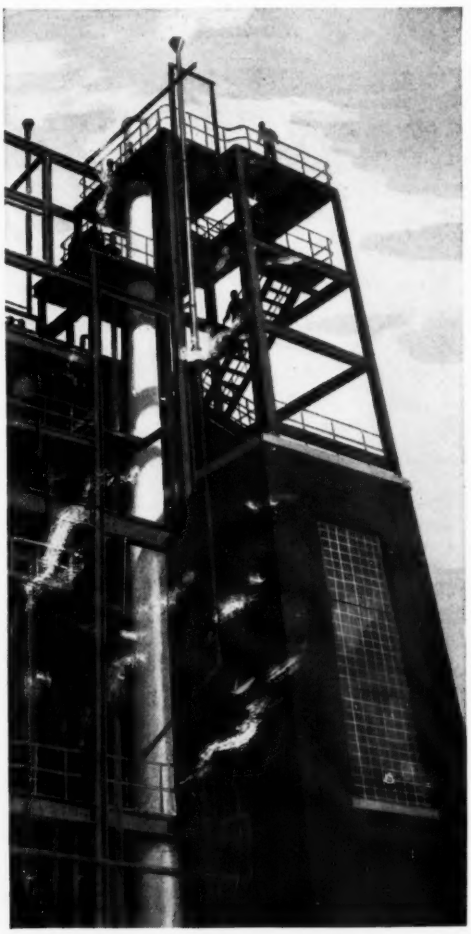
Stability is most important, for a charge of grease on any intricate mechanism must function dependably for a considerable period of time. Some ball bearing motors may go for many months without re-lubrication.

Stability indicates that the grease will be resistant to separation and oxidation. Leakage and soap deposits would be an indication that separation has occurred. Oxidation may cause gumming and varnish-like deposits.

The Effect of Moisture

The possibility of moisture-contamination of lubricants is of importance in some phases of soap-making. In this consideration, it is necessary to include gears and chains as well as the bearings. Wherever continued exposure to or contact with moisture may prevail, the lubricant should be able to emulsify with water to some extent. In this way a lubricating film is formed which will be resistant to the washing action of water.

Emulsification in lubricating oils is promoted by compounding straight mineral oils with a small amount of animal or vegetable oil. In other words,



Courtesy of The Proctor & Gamble Company

Figure 2 — In contrast to the soap kettle note the appearance of an 8 story hydrolyzer.

when certain fixed oils of such origin, or some types of soaps are added to a mineral oil, if the subsequent compound is mixed and agitated with water, the resultant emulsion of the two liquids will separate very slowly or even stay in an emulsified state indefinitely. Emulsification is essentially a physical reaction, but a very necessary one wherever lubrication under wet conditions is necessary.

Some sodium soap greases behave in a similar manner. Emulsions are usually quite tenacious or sticky. On the other hand they may not be very stable chemically in which case they may become corrosive due to increased acidity. Then there is likelihood that the emulsion in question may become actually gummy due to oxidation. This can be retarded however, if the lubricant has been carefully refined to insure removal of unstable hydro-carbon components which are most easily oxidized. The machine operator can help by observing regular and frequent periods of renewal of lubricants, and establishing a cleaning schedule

The relation which acidity bears to emulsification and sludge formation has received considerable study. Due to the extreme complexity of constituents such as are formed by sulfur and oxygen and the limited knowledge of their emulsifying tendencies, progress is slow in this field.

Were these reactions more clearly identified or could petroleum oils be refined so as to entirely remove or neutralize their organic acid-forming constituents, the problem of corrosion protection might be materially simplified. Until this objective is attained, efforts can only be made to render such oils as chemically stable as possible, especially when they are to be exposed to moisture and oxidizing conditions.

Saponification in Grease Making

In contrast with emulsification, saponification is a chemical reaction which has to do with the production of soaps by treatment of a fatty oil with certain types of alkaline solutions. It is one of the essential steps in grease making.

One of the distinctive differences between fixed or fatty oils and petroleum oils involves the ability of the former to undergo a simple chemical reaction whereby the original compounds are split up and their elements re-combined chemically with certain alkalis. When the larger portion of the fatty oil molecules are combined with a metal such as sodium, calcium or aluminum, a soap adaptable to grease making is formed by this process of saponification.

The petroleum chemist prepares these soaps so that they will resist the dissociating effect of water, or will emulsify according to intended service. Then, he carefully selects his mineral oil constituent and plans a method of procedure which will give a high temperature grease, a water-resistant product or one of fibrous nature.* All according to the basic materials, the temperatures involved in mixing, the rate of mixing and whether the finished grease is poured hot or cold.

THE SEVERAL STAGES IN SOAP-MAKING

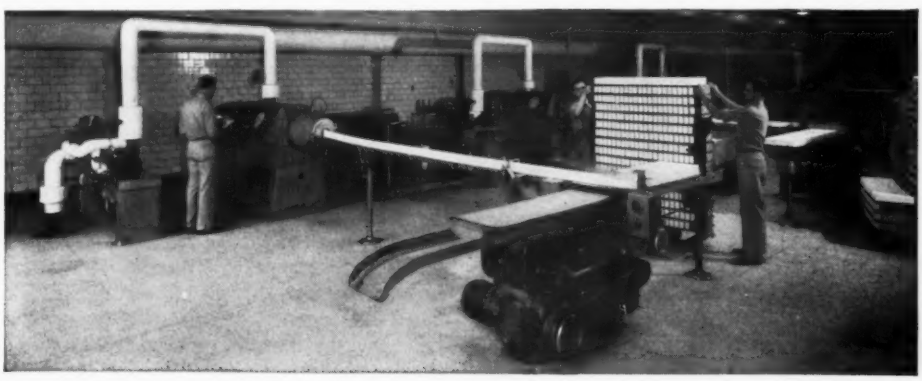
From the viewpoint of lubrication, the soap industry can be divided into three parts:

a. Power;
b. Processing;
c. Packaging.

The Power Department includes all the machinery in the power plant such as the boiler room pumps, steam engines or turbines, the air compressors and the hydrogen compressors which handle the hydrogen for the hydrogenation process.

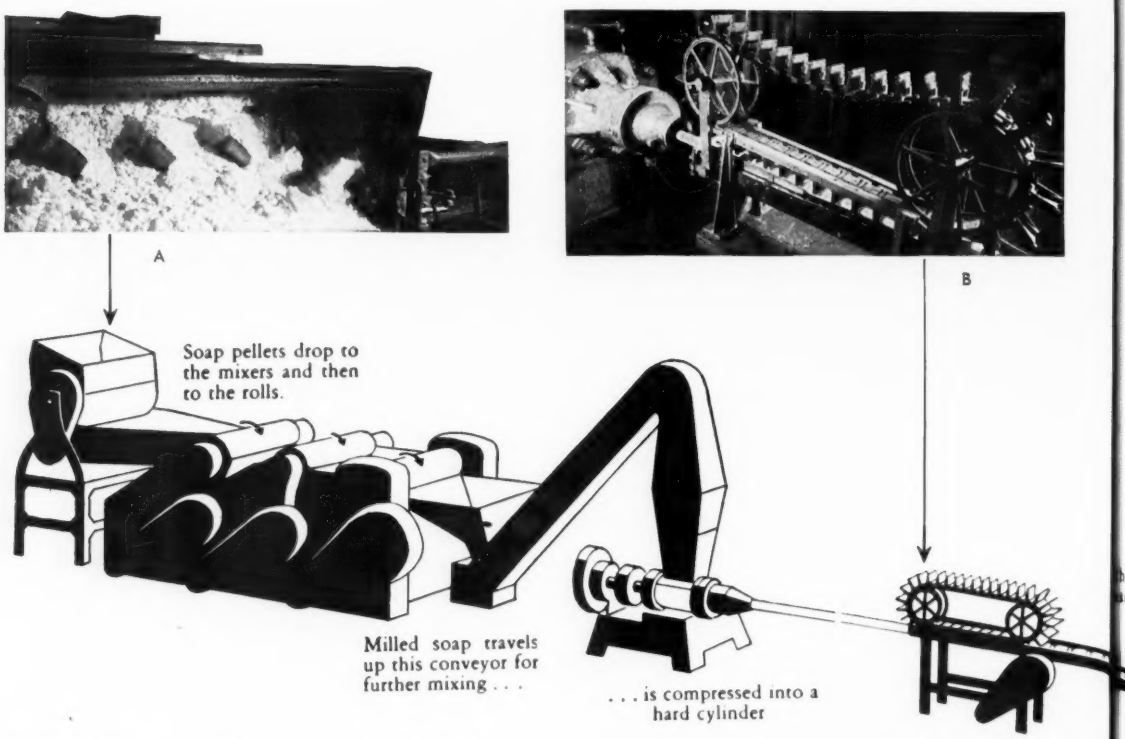
The Processing Department includes the pumps

*See LUBRICATION May 1945, Greases—Part I—Their Manufacture; August 1945, Greases—Part II—Their Characteristcs and Uses.



Courtesy of The Proctor & Gamble Company

Figure 3 — Arrangement of a battery of mechanical freezers used in making endless bar soap. Note from left to right, the mixer, freezer and high speed cutter. Soap is delivered to the mixer via the white pipe coming up through the floor, after mixing it goes to the freezer from which it extrudes in bar form to the cutter.


A
B
Soap pellets drop to the mixers and then to the rolls.
Milled soap travels up this conveyor for further mixing . . .
. . . is compressed into a hard cylinder
Cut, shaped and passed al

in the kettle rooms; the mixers and mills which are used for toilet soaps; the rolls which are required in making soap chips or flakes and the bar cutters.

Packaging may be said to begin with the stamping and forming machines. It includes the wrapping machines and any conveyors required for moving the finished containers.

The primary requirement in lubricating machinery in the soap plant is cleanliness. It parallels the primary purpose of the soap itself.

THE RAW MATERIALS

A wide variety of oils are used in the making of soap, according to the type of finished product desired. Some of the most suitable vegetable oils are derived from coconut meats (copra), palms, sunflower seeds, olive pulp, soybeans, peanuts and cottonseed. The perfume or essential fragrant oils are extracted from flowers. In addition, certain fish oils as well as a considerable amount of animal fats are used.

These raw materials must be refined after being received at the plant. The refining process includes bleaching and other forms of treatment such as filtration, to prepare these oils for the soap maker.

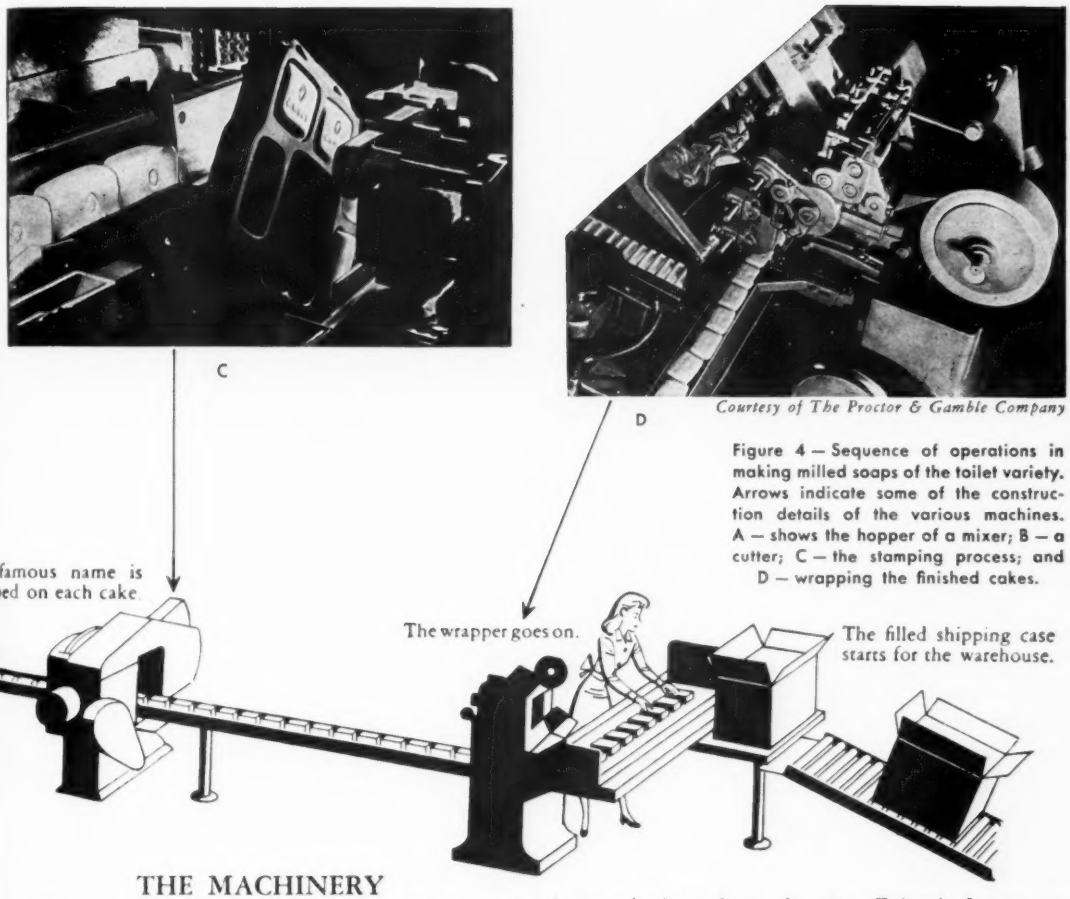
THE MANUFACTURING PROCESSES

The Soap Kettle

This process, which is a modern refinement of the process which was evolved centuries ago and carried on with but little change till early in the 19th Century, requires a vertical cylindrical kettle about 3 stories high. In this kettle, fats, oils and soda are boiled or cooked for a predetermined length of time — usually several days. Then salt is added. This separates the soap from the glycerine, and the former being lighter, rises to the top. Further boiling of the separated soap with soda develops a purifying action and when completed, the soap is ready for processing.

The Hydrolyzer Process

Since the kettle process requires several days, mass production methods were extended to the soap industry several years ago, and the continuous hydrolyzer process was developed. The purpose of this process is to "split" the fats which are desired for soap-making, from the glycerine. To accomplish this high pressure and high temperature are required. The procedure is to pump the fats into the hydrolyzer tower at the bottom and scalding water in at the top. As the fats rise through the hot water they "split" into the fatty materials used in making soap and into glycerine. Fatty acids are removed at the top of the tower, distilled and then neutralized to form soap.



Courtesy of The Proctor & Gamble Company

Figure 4 — Sequence of operations in making milled soaps of the toilet variety. Arrows indicate some of the construction details of the various machines. A — shows the hopper of a mixer; B — a cutter; C — the stamping process; and D — wrapping the finished cakes.

THE MACHINERY

The machinery required for the manufacture of soap can be grouped into two broad classifications, viz: as involved in making the soap, and subsequently, as involved in the processing and packaging of the product for the market.

The older, more conventional method of making soap, before the hydrolyzer process was perfected, involved boiling the ingredients — fats and alkalis — in a kettle. This procedure is still followed to some extent. The hydrogenation process in turn further revolutionized the soap industry by enabling it to add edible oils and cooking fats to its list of products. Credit for the development of this process —which has subsequently been adopted by the petroleum industry — goes to the soap chemists who worked it out shortly after the turn of the century.

In kettle boiling the only machines requiring lubrication are the pumps used for pumping the raw materials to the kettles and later for transferring the hot liquid soap to the processing department. These pumps present no serious lubrication problems and mechanical force feed lubricators with leads to the bearings are used to good advantage. In the processing department, however, where the soap may have to be heated to soften it sufficiently for pumping, the bearings of the gear pumps which are used may run so hot as to require special attention as to lubrication. This applies also to the mixer bearings.

POWER

Power is in reality a by-product of the steam boiler plant. The soap industry uses a huge amount of steam for process heating. This requires an extensive boiler plant. The best heat balance is obtained by generating steam to between 800 and 900 pounds pressure, using live steam for power generation via steam turbines and exhausting the steam at around 150 pounds. This exhaust is then used for many of the process heating operations.

HYDROGENATION REQUIRES HYDROGEN COMPRESSION

This process involves the use of hydrogen for solidifying the vegetable oils which are used in the manufacture of shortening or cooking products. The average plant makes its own hydrogen, compressing it to around 250 to 300 pounds by 2-stage compression prior to agitation with the cotton seed or soyabean oil.

. . . Flaked soaps start out like other soaps in either the kettle or the hydrolyzer.
Then are mixed in a compact mixing machine.
A small hot roll and a larger cold roll produce long ribbons of soap.
Steam-heated dryers remove the moisture from the ribbons.
Further processing dries and fluffs the tissue-thin flakes.

Courtesy of The Proctor & Gamble Company

Figure 5 — Sequence of operations in making flaked soaps.

Compressor Lubrication

Hydrogen compression requires that due precaution be taken to prevent leakage of air into the system during the suction stroke of the compressor. Accordingly, the intake must be above atmospheric pressure, or oil in the stuffing box must be under pressure. These precautions are necessary because while hydrogen itself is not an explosive gas, mixtures with oxygen or air are violently explosive or inflammable.

The comparatively moderate pressure requirements in hydrogen compression as indicated above, fortunately, do not impose severe duty upon the compressor oil. A straight mineral compressor oil of around 300 seconds Saybolt Universal Viscosity is generally suitable. Horizontal machines are usually involved, the oil being fed to the cylinders by mechanical force-feed lubricators. Obviously, the rate of feed should be controlled to avoid excess oil in the cylinders and possibility of carbonization under the prevailing temperatures.

REFRIGERATION

This is required in the making of bar soap where the hot soap is pumped through a cooling machine. The cooling machine uses knives for scraping and mixing the chilled soap from a cylindrical cooling wall. The cooled soap is then extruded in strip form.

Ammonia or one of the "Freon" refrigerants is generally used. The system must be tightly sealed to prevent leakage.

How Refrigeration Works

As a preliminary to discussion of refrigeration machinery, it is of interest to note that there are two stages:

1. Evaporation and expansion of the refrigerant whereby heat is absorbed from the surroundings, and,
2. Compression and condensation, whereby the heat is in turn abstracted from the refrigerant and the latter converted to liquid form once again.

In a compression refrigeration set-up the system includes the evaporator, compressor, oil separator, condenser, receiver, and expansion valve.

Compressors may be of the horizontal or vertical, reciprocating single or double acting type or centrifugal compressors may be used.

In the compression process, the refrigerant or cooling agent is recovered after each expansion by means of mechanical compression.

In operation, the gaseous refrigerant in a compression system must be sufficiently compressed and cooled to convert it to liquid form. Under compression alone, it will still remain as a gas since pressure raises the temperature above the liquefaction point. Some form of condenser must therefore be used.

Prior to condensation, however, the gas usually is passed through a suitable oil separator or trap in order to free it of any excess lubricant. From the oil separator the hot gas then passes to the condenser, where its temperature is reduced by means of air or cold circulating water to convert it to liquid form. It then functions as a cooling medium.

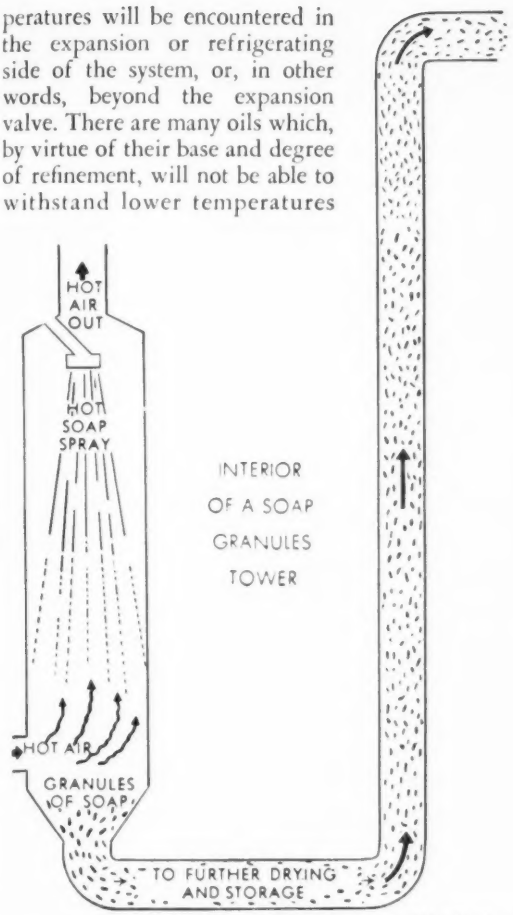
Cooling is brought about by reducing the pressure. Some systems pass the refrigerant through an expansion or regulating valve to the evaporating side of the system. Here, due to a considerable drop in pressure, it evaporates and is able to take up heat from the surroundings. It is then returned to the compressor to repeat the cycle.

Selecting the Oil

Lubrication of refrigerating machinery is unique in that the action and effects of the compressor oil upon parts not requiring lubrication must be considered along with the lubricating ability. To overlook or disregard the importance of such factors as the method of lubrication, the temperature in the expansion or refrigerating coils, the mechanical condition of the compressor, and the location, type and efficiency of the oil separator may frequently lead to higher maintenance costs and reduction in capacity.

Oil congealed in any part of the cooling system will tend to reduce refrigerating efficiency if it becomes so sluggish under the low temperatures involved as to form an interior lining in the expansion coils; this will affect the heat transfer. Oil in the condenser will affect the head pressure. An oil for refrigerating machinery lubrication therefore, must remain fluid at the lowest temperature to which it may be subjected during the operation. These tem-

peratures will be encountered in the expansion or refrigerating side of the system, or, in other words, beyond the expansion valve. There are many oils which, by virtue of their base and degree of refinement, will not be able to withstand lower temperatures



Courtesy of The Proctor & Gamble Company

Figure 6 — Flow chart showing how granulated soaps are made.

without congealing to a certain extent, depending upon the wax content.

When congealment occurs a film of oil will be deposited on the inner surface of the refrigerating piping to form an insulating layer which will prevent proper abstraction of heat from the compartment or medium which is to be cooled. If this is allowed to continue, the refrigerating capacity of the system will be reduced and ultimately it will be necessary to clean out these congealed oil deposits.

Type of Oil

Where the temperature in the refrigerating coil is below 5° F. a straight mineral filtered low pour test oil having a viscosity around 150 seconds Saybolt at 100° F. will be necessary. Above this temperature, however, an oil of somewhat higher viscosity, i.e. 200 to 500 seconds Saybolt depending upon the recommendation of the compressor builder, will give satisfactory results A highly refined distilled mineral oil should be used to assure that these requirements are met. Such oils will lubricate effectively with a minimum of vaporization, under the usual operating conditions which prevail. The lower the viscosity the lower the pour test will be for oils of the same degree of refinement.

Lubricating Systems

Splash and pressure lubrication are used in industrial refrigerating compressors. The latter is suited for the lubrication of both vertical and horizontal machines. The former, however, is more adaptable to the small size vertical compressor. Force feed oil circulation is used on the centrifugal machines.

The lubricating system must be considered when deciding upon the oil viscosity; a pressure lubrication system can often handle a higher viscosity oil than a splash system. It also assures of accurate control of the amount of oil delivered to cylinder walls and bearings.

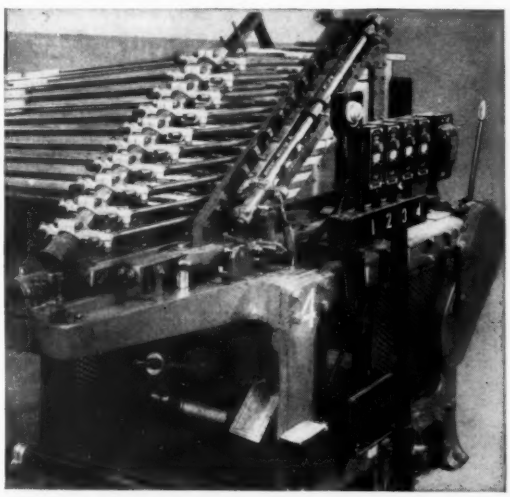
Mechanical Force Feed Oilers

External lubricators of this type are used in lubricating cylinders of reciprocating machines. Excellent economy will be attained by regulating such lubricators as recommended by the compressor builders, so that just enough oil is delivered to maintain the requisite lubricating films.

Many of such machines are designed for individual lubrication of the internal and external parts. In other words, a mechanical lubricator with two or more outlets is used for cylinder and stuffing box service, and an independent gravity or mechanical pressure circulating system for all external bearings.

SELECTING THE LUBRICANTS FOR PACKAGING MACHINERY

Throughout the entire soap plant purity and



Courtesy of Standard Knapp, Div. of Hartford Empire Company

Figure 7 — The operating mechanism of a shipping container packer for packing soap bars.

cleanliness are stressed; they are doubly important when the soap bars are cut for wrapping or the flakes or granules are running to the packaging machines. Soap packaging machinery, therefore, is designed for the protection of the materials being handled. Automatically this implies that the lubricants required will be protected against possible contamination. Many of the mechanisms are intricate; they will require but little lubrication but this must be carefully controlled.

Design is a criterion as to the degree of refinement essential in a lubricant. In packaging machine service, it may be presumed that highly refined lubricants are always advisable. Specific usage will control specific characteristics which may be embodied in a general lubrication recommendation when the designing engineer has completed his assignment. Even so such a recommendation is more or less of an ideal, for it is based upon modern design and the assumption that the builders realize the importance of lubrication and the necessity for protecting the moving parts as much as possible.

On the other hand, whereas a very high grade of grease or a filtered straight mineral oil would be adaptable to such a type of design, where an older installation is involved it may be necessary to substitute a product which from a price point of view will be in line with the existing conditions.

It is for this reason, that it is often advisable for a working lubrication recommendation to include two or more grades of lubricants of varying degree of refinement. Where oils are involved, they should be of approximately the same viscosity, commensurate with the speed, operating pressure, and the extent to which temperature variation may occur.

Wherever grease is to be used it is well to remember that such a product is more particularly adaptable to mechanisms where the cohesive ability of the lubricant will assist in its retention. If a ball bearing for example, is properly designed to retain the lubricant, and a product chosen with a high degree of lubricating ability, lubrication will be assured for an extensive period of operation, with the necessity for only infrequent renewal.

The average ball or roller bearing should not be completely filled with lubricant, for this may not only lead to channelling of the product but also to increased power consumption, due to the drag which may be imposed upon the rolling elements.

Wherever gears, chains or other motions are involved however, speed must be studied from the viewpoint of the extent to which centrifugal force will be developed and the lubricant thrown from the moving parts. Here there is a greater relationship between speed and the adhesive characteristics of the lubricant. This will be especially true on exposed gears or chains. In an oil-tight gear or chain housing a comparatively fluid oil can be used, especially if it is automatically delivered to the parts and not merely carried to them when the gear teeth or chain sprockets dip in the bath of lubricant.

Either oil or grease can be used satisfactorily for many of the bearings; it will depend upon the type of lubricating equipment available, and the operating conditions such as speed and bearing pressures and details of construction such as manner of grooving of plain bearings.

Some form of positive or automatic lubrication is generally provided as an adjunct to keeping the lubricant where it belongs. Positive lubrication also counteracts machine pressures most effectually.

In virtually any piece of machinery where pressure may prevail it is important to remember that it is the "operating pressure" which must be considered. When idling, the pressure which may exist between the gear teeth or upon the bearings of certain of the shafting may not be abnormal. When idling there should, therefore, be no problem in the maintenance of lubrication. During operation, however, the pressure developed will react back through practically all the moving elements of the machine. The intensity depends upon the size or relative importance of the parts involved. In general, such reactionary or back pressures will be considerably in excess of the idling pressures, and hence they can be a potential cause of lubricating difficulties.

Where relatively high operating temperatures may prevail the proper viscosity or body of a lubricant must be given all the more careful attention, for viscosity will vary inversely with temperature. In other words, the higher the operating temperature the greater will be the tendency for the body or viscosity of the lubricant to be reduced. If the original viscosity is not sufficiently high to allow for this reduction, the increased fluidity may lead to impairment of the lubricating film to such an extent as to actually allow metal-to-metal contact.

CONCLUSION

Washing has been a ritual since biblical days — even before — since archeologists have uncovered remains of soap-making facilities on the shores of the Mediterranean Sea. Until the Machine Age promoted the use of soaps in the manufacture of lubricating greases, soap was essentially a cleansing material. Yet, soap-making was an active industry centuries before the Machine Age. From Italy and Germany in the 13th Century, it spread to France and soon after to England. In the early American Colonies, soap-making was practiced in virtually every pioneer household.

Today, soap is one of the vital essentials of civilization. Its manufacture requires a thoroughly coordinated procedure which is rendered most dependable when the machinery involved is lubricated effectively.

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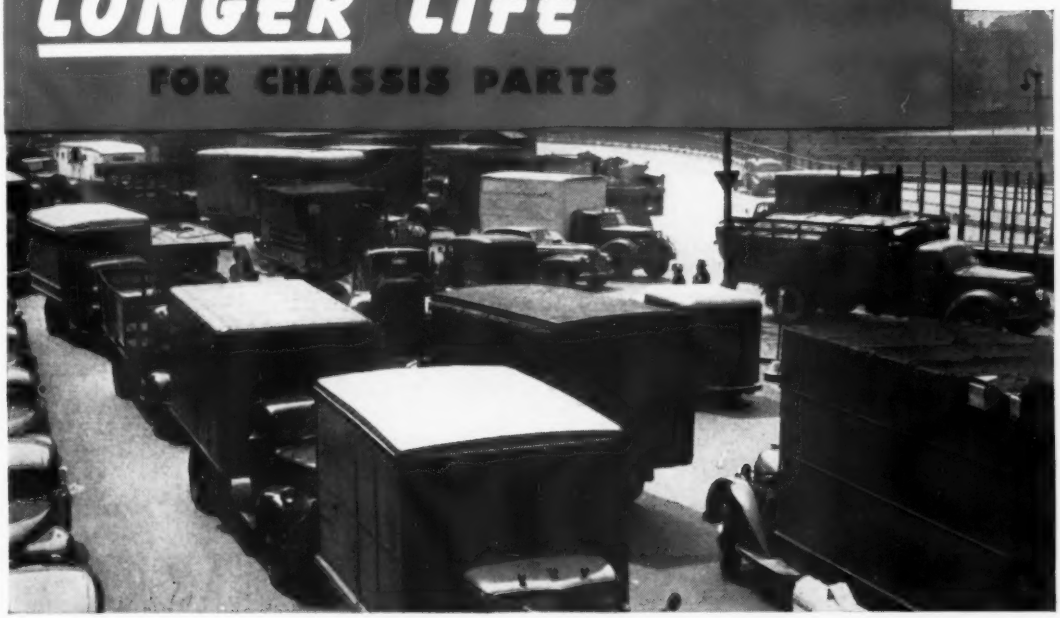

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This is in line with the quality standards that govern Maytag production . . . for only through highest quality, consistently maintained, could The Maytag Company, Newton, Iowa, have built more than 6,000,000 washing machines—far more than any other manufacturer.

The part that Texaco Lubrication Engineering Service plays is important, too. As new washer designs are developed, new lubricant requirements arise . . . and Maytag and Texaco engineers work together to meet them. Increased production, improved performance, and lower unit costs are among the resultant benefits.

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